



April 20, 2009

TO: Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

FROM: Stephen B. Ackerman, Reg. No. 37,761  
28 Davis Ave.  
Poughkeepsie, NY 12603

SUBJECT: Serial #: 10/714,305  
File Date: 11/14/2003  
Inventors: J-W Chang, C-P Chen, C. Lao, and S. Kao  
Title: SINGLE LAYER RESIST LIFTOFF PROCESS FOR NANO  
TRACK WIDTH  
Art Unit: 1756  
Examiner: D. Chacko Davis

## APPEAL BRIEF

Dear Sir:

In response to the Final Rejection of Claims 1-3, 5-9 dated October 20 2008, please accept this Appeal Brief.

## CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on April 20, 2009.

Signature

Date: April 20, 2009Name Stephen B. Ackerman, Reg. # 37,761 04/23/2009 TLUU11 00000004 190033 10714305

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The Commissioner is hereby authorized to charge payment of the fee of \$540.00 associated with this communication to Deposit Account No. 19-0033. A duplicate copy of this sheet is enclosed.



Stephen B. Ackerman, Reg. No. 37,761

**REAL PARTY IN INTEREST**

The real party in interest is the assignee, Headway Technologies Inc., Milpitas, CA. An assignment has been recorded in this case.

**RELATED APPEALS AND INTERFERENCES**

There are no known Appeals or Interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending Appeal for the subject Application for Patent.

**STATUS OF THE CLAIMS**

Claims 1-3 and 5-9 are pending in the Patent Application and have been rejected. This appeal is to the rejection of Claims 1-3 and 5-9. The Claims Appendix has a Listing of the Claims in numerical sequence.

**STATUS OF THE AMENDMENTS**

No amendments have been filed subsequent to the Final Rejection dated October 20, 2008.

**SUMMARY OF THE CLAIMED SUBJECT MATTER**

1. A liftoff method for photolithography, comprising:
  - depositing a single layer of photoresist on a substrate (page 7 line 16);
  - exposing and developing said photoresist layer thereby forming a photoresist pattern having sidewalls and an upper surface (element 14 of FIG. 2);
  - irradiating said upper surface with an ion beam (element 31 of FIG. 3) having a direction parallel to said sidewalls, said ion beam comprising ions whose energy is too low to sputter said layer of photoresist ;
  - maintaining said ion beam irradiation for a time period whereby a hardened layer (element 34 of FIG. 3) is formed that extends a distance downwards from said upper surface, all remaining photoresist being unhardened; (see page 8, lines 1-8)
  - then exposing said photoresist pattern to ozone (elements 41 of FIG. 4) whereby said sidewalls are eroded and said hardened layer is unchanged so that the hardened layer overhangs the unhardened layer; (oxide layer 42 is also formed at this time but is not part of claim 1, thereby maintaining the generality of this claim. Similarly, the device-specific step of ion milling by means of element 51 in FIG. 5, for the purpose of

patterning layer 12, is not claimed either, layer 52 in FIG. 5 being the remaining portion of layer 42)

depositing a layer of a material (element 61 of FIG. 6) onto all horizontal surfaces to a thickness that is less than that of said unhardened photoresist layer (see page 9 lines 2-5); and

selectively removing said unhardened photoresist layer whereby all of said material that is deposited onto said hardened photoresist layer is lifted off (FIG. 7).

Claim 4 was previously canceled. Claims 2-3 and 5-9 are all dependent on claim 1.

#### **GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

I. The rejection of claims 1-3 and 5-9, as amended, under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.).

II. The rejection of claim 7 under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.) and further in view of US2002/0001957 (Kim et al.).

III. The rejection of claim 9 under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.) and further in view of US5,512,334 (Leuschner et al.).

## ARGUMENT

I. Reversal of Examiner's rejection of claims 1-3 and 5-9 under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.) and further in view of US5,512,334 (Leuschner et al.) is respectfully requested.

The invention discloses a method to form a liftoff resist **from a single layer of one material**. Conventional photoresist (positive or negative) is first patterned in the conventional way. Then, the **top surface (only)** is exposed to a beam of ions **whose energy is too low to cause sputtering**. Said ions penetrate a short distance beneath the photoresist surface, forming there a hardened layer. This is followed by exposure to ozone which erodes all exposed photoresist surfaces except the aforementioned hardened layer, causing the latter to overhang the untreated (i.e. relatively soft) layer beneath it, thereby rendering it suitable for subsequent use as a liftoff mask.

[Note: phrases in bold represent several of the features of the present invention believed to render the rejected claims patentable]

### Overview of Yamada:

The sequence of steps disclosed by Yamada begins in col. 3 line 22:

- (i) Photoresist pattern 15 is used as a mask to shape electrode 14.
- (ii) Resist 15 is shrunk by oxygen gas plasma etching so that a small amount of electrode 15 (referred to as a terrace) now extends beyond the resist's sidewalls at its base.

(iii) Insulating film 16 is deposited; it coats the top surface of pattern 15, the exposed parts of layer 12, and (most important for Yamada) the top and sides of the afore-mentioned terrace, forming what Yamada then refers to as an overhang.

(iv) Pattern 15 is removed, thereby causing that portion of layer 16 that lies on the pattern's surface to be lifted off. The remainder of layer 16 is left in place including the overhang. The latter have been circled by broken lines in Yamada's FIG. 2.

In FIG. 1(c), layer 16 on the top surface of photoresist 15 is shown as overhanging 15. It is unclear whether or not this could actually occur in practice but, regardless, it is important to note that layer 16 is deposited insulation and not modified photoresist.

Following the above description, Yamada notes (col. 3 lines 47-51) that "it is required to harden the resist film surface by sputter cleaning with high energy particles". Later, in col. 5 lines 1-5, Yamada notes that sputter etching of the resist is performed at an RF power of 20W (voltage not specified). It is important to note that sputter etching as described by Yamada is not the same as the ion beam irradiation claimed in claim 1 of the present invention. In Yamada's case, all exposed surfaces are subjected to ion bombardment whereas the ion beam of the present invention impinges only on the top surface of the resist since it is directed to be parallel to the resist's sidewalls, as stated in claim 1:

"irradiating said upper surface with an ion beam having a direction parallel to said sidewalls, said ion beam comprising ions whose energy is too low to sputter said layer of photoresist;"

In making the case for rejecting claim 1, Examiner alleges that Yamada teaches the following:

- (a) A single photoresist layer (including an overhanging top layer).
- (b) Ion beam irradiation or sputter cleaning too weak to etch the resist pattern surface.

(c) The top portion of the resist pattern (upper portion) overhangs the bottom shrunk portion.

In response, Applicant has contended the following:

(a) The overhanging top layer seen in Yamada's drawings is not photoresist but insulation.

(b) Yamada explicitly states that high energy ion beam irradiation is to be used. Furthermore, by definition, sputter cleaning works by removing some of the surface material. If no material is removed, sputtering has not occurred.

(c) Yamada's reference to an overhang is to the small amount of deposited insulation that overhangs his terrace.

In rejecting claim 1, Examiner has further relied on US 6,833,234 (Bloomstein et al.) specifically in regard to the shrinking of photoresist through exposure to ozone. In light of our foregoing argument that Yamada teaches neither an overhanging top layer of photoresist, nor bombardment by ions of energy too low to cause sputtering, nor use of an ion beam whereby ion bombardment is limited to the top surface of the resist, it is believed that the Bloomstein reference is no longer relevant.

Claims 2-3 and 5-9 are all dependent on claim 1 so the anticipated allowance of claim 1 will render them allowable too.

In conclusion, examiner appears to have mistakenly equated Yamada's insulating layer (that overhangs a terrace at the base of his photoresist) with the hardened photoresist layer of the present invention (that overhangs the photoresist from the latter's top surface). Additionally, examiner has failed to cite prior art that teaches forming said overhanging top portion by first bombarding said top layer by means of an ion beam whose ions have energies that are too low to cause sputtering.

II. Reconsideration of Examiner's rejection of claim 7 under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.) and further in view of US5,512,334 (Leuschner et al.) is respectfully requested.

Claim 7 is believed to be patentable since it depends on Claim 1, which is believed to be patentable for the reasons recorded above in section I.

III. Reconsideration of Examiner's rejection of claim 9 under 35 USC 103(a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al.) and further in view of US5,512,334 (Leuschner et al.) is respectfully requested.

Claim 9 is believed to be patentable since it depends on Claim 1, which is believed to be patentable for the reasons recorded above in section I.

### SUMMARY

It is believed that Claims 1-3 and 5-9 distinguish patentably from the references and should be allowed. Reversal of the rejection of the pending claims is therefore respectfully requested.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "S B Ackerman".

Stephen B. Ackerman, Reg. No. 37,761

**CLAIMS APPENDIX****Listing of Claims:**

1. A liftoff method for photolithography, comprising:
  - depositing a single layer of photoresist on a substrate;
  - exposing and developing said photoresist layer thereby forming a photoresist pattern having sidewalls and an upper surface;
  - irradiating said upper surface with an ion beam having a direction parallel to said sidewalls, said ion beam comprising ions whose energy is too low to sputter said layer of photoresist;
  - maintaining said ion beam irradiation for a time period whereby a hardened layer is formed that extends a distance downwards from said upper surface, all remaining photoresist being unhardened;
  - then exposing said photoresist pattern to ozone whereby said sidewalls are eroded and said hardened layer is unchanged so that the hardened layer overhangs the unhardened layer;
  - depositing a layer of a material onto all horizontal surfaces to a thickness that is less than that of said unhardened photoresist layer; and
  - selectively removing said unhardened photoresist layer whereby all of said material that is deposited onto said hardened photoresist layer is lifted off.
2. The liftoff method recited in claim 1 wherein said layer of photoresist is a negative resist or a positive resist.

3. The liftoff method recited in claim 1 wherein said layer of photoresist is deposited to a thickness between about 0.1 and 0.4 microns.

4. (canceled)

5. The liftoff method recited in claim 1 wherein said time period for which said ion beam irradiation is maintained is between about 2 and 20 minutes.

6. The liftoff method recited in claim 1 wherein said distance for which said hardened layer extends downwards is between about 100 and 500 Angstroms.

7. The liftoff method recited in claim 1 wherein the step of exposing said photoresist pattern to ozone further comprises placing the wafers in an ozone chamber, heating them to between 70 and 150 °C at an ozone concentration of between 10 to 200 gm/m<sup>3</sup> at an ozone flow rate of 1 to 100 L/minute for between 1 and 60 minutes.

8. The liftoff method recited in claim 1 wherein said hardened layer overhangs the unhardened layer by between about 0.01 and 0.1 microns on each side.

9. The liftoff method recited in claim 1 wherein the step of selectively removing said unhardened photoresist layer further comprises using N-methyl-2-pyrrolidone at a temperature between 50 and 90 °C for 30 to 60 minutes.

10 – 35. Canceled.

## **EVIDENCE APPENDIX**

**None.**

## **RELATED PROCEEDINGS APPENDIX**

**None.**